

CLAIM AMENDMENTS

This listing of claims will replace all prior versions, and listings, of claims in the application.

1 1. (Previously Presented) A method of determining a placement of services of a
2 distributed application onto nodes of a distributed resource infrastructure comprising
3 the steps of:

4 establishing a placement indicator for a specific service;

5 forming communication constraints between node pairs which ensure that a
6 sum of transport demands between a particular node pair does not exceed a
7 transport capacity between the particular node pair, each term of the sum
8 comprising a product of a first placement variable, a second placement variable,
9 and the transport demand between the services associated with the first and
10 second placement variables;

11 forming an objective; and

12 employing a local search solution to solve an integer program comprising the
13 placement indicator, the communication constraints, and the objective to
14 determine the placement of the services onto the nodes.

1 2. (Original) The method of claim 1 wherein the placement indicator comprises a
2 pre-defined placement.

1 3. (Original) The method of claim 2 wherein the pre-defined placement comprises
2 placing the specific service onto a specific node.

1 4. (Original) The method of claim 2 wherein the pre-defined placement comprises
2 not placing the specific service onto a specific node.

1 5. (Original) The method of claim 1 wherein the placement indicator comprises a
2 neutral indication of whether the specific service is to be placed onto a specific node.

1 6. (Previously Presented) A method of determining a placement of services of a
2 distributed application onto nodes of a distributed resource infrastructure comprising
3 the steps of:

4 establishing an application model of the services comprising transport
5 demands between the services;

6 establishing an infrastructure model of the nodes comprising transport
7 capacities between the nodes;

8 establishing a placement model comprising placement indicators for the
9 services;

10 forming an integer program that comprises:

11 a set of placement variables for a combination of the services and the
12 nodes, each of the placement variables indicating whether a particular service
13 is located on a particular node;

14 communication constraints between node pairs which ensure that a sum of
15 the transport demands between a particular node pair does not exceed the
16 transport capacity between the particular node pair, each term of the sum
17 comprising a product of a first placement variable, a second placement
18 variable, and the transport demand between the services associated with the
19 first and second placement variables;

20 placement constraints for the services which ensure that the services are
21 placed onto the nodes in accord with the placement indicators; and

22 an objective; and

23 employing a local search solution to solve the integer program which
24 determines the placement of the services onto the nodes.

1 7. (Original) The method of claim 6 wherein a particular placement indicator
2 comprises an indication that a specific service is to be placed onto a specific node.

1 8. (Original) The method of claim 6 wherein a particular placement indicator
2 comprises an indication that a specific service is not to be placed onto a specific node.

1 9. (Original) The method of claim 6 wherein a particular placement indicator
2 comprises a neutral indication of whether a specific service is to be placed onto a
3 specific node.

1 10. (Original) The method of claim 9 wherein a default for the placement indicators
2 comprises the neutral indication.

1 11. (Previously Presented) A method of determining a placement of services of a
2 distributed application onto nodes of a distributed resource infrastructure comprising
3 the steps of:

4 establishing an application model of the services that comprises processing
5 demands for the services, storage demands for the services, and transport
6 demands between the services;

7 establishing an infrastructure model of the nodes that comprises processing
8 capacities for the nodes, storage capacities for the nodes, and transport capacities
9 between the nodes;

10 establishing a placement model comprising placement indicators for the
11 services;

12 forming an integer program that comprises:

13 a set of placement variables for a combination of the services and the
14 nodes, each of the placement variables indicating whether a particular service
15 is located on a particular node;

16 processing constraints which ensure that a sum of the processing demands
17 for each of the nodes does not exceed the processing capacity for the node;

18 storage constraints which ensure that a sum of the storage demands for
19 each of the nodes does not exceed the storage capacity for the node;

20 first placement constraints which ensure that each of the services is placed
21 on one and only one node;

22 second placement constraints which ensure that the services are placed
23 onto the nodes in accord with the placement indicators;

communication constraints between node pairs which ensure that a sum of the transport demands between a particular node pair does not exceed the transport capacity between the particular node pair, each term of the sum comprising a product of a first placement variable, a second placement variable, and the transport demand between the services associated with the first and second placement variables; and

an objective of minimizing communication traffic between the nodes and balancing processing loads on the nodes; and

employing a local search solution to solve the integer program which determines the placement of the services onto the nodes.

12. (Previously Presented) A computer readable memory comprising computer code for directing a computer to make a determination of a placement of services of a distributed application onto nodes of a distributed resource infrastructure, the determination of the placement of the services onto the nodes comprising the steps of:

establishing a placement indicator for a specific service;

forming communication constraints between node pairs which ensure that a sum of transport demands between a particular node pair does not exceed a transport capacity between the particular node pair, each term of the sum comprising a product of a first placement variable, a second placement variable, and the transport demand between the services associated with the first and second placement variables;

forming an objective; and

employing a local search solution to solve an integer program comprising the placement indicator, the communication constraints, and the objective to determine the placement of the services onto the nodes.

13. (Original) The computer readable memory of claim 12 wherein the placement indicator comprises a pre-defined placement.

14. (Original) The computer readable memory of claim 13 wherein the pre-defined

2 placement comprises placing the specific service onto a specific node.

1 15. (Original) The computer readable memory of claim 13 wherein the pre-defined
2 placement comprises not placing the specific service onto a specific node.

1 16. (Original) The computer readable memory of claim 12 wherein the placement
2 indicator comprises a neutral indication of whether the specific service is to be placed
3 onto a specific node.

1 17. (Previously Presented) A computer readable memory comprising computer code
2 for directing a computer to make a determination of a placement of services of a
3 distributed application onto nodes of a distributed resource infrastructure, the
4 determination of the placement of the services onto the nodes comprising the steps of:

5 establishing an application model of the services comprising transport
6 demands between the services;

7 establishing an infrastructure model of the nodes comprising transport
8 capacities between the nodes;

9 establishing a placement model comprising placement indicators for the
10 services;

11 forming an integer program that comprises:

12 a set of placement variables for a combination of the services and the
13 nodes, each of the placement variables indicating whether a particular service
14 is located on a particular node;

15 communication constraints between node pairs which ensure that a sum of
16 the transport demands between a particular node pair does not exceed the
17 transport capacity between the particular node pair, each term of the sum
18 comprising a product of a first placement variable, a second placement
19 variable, and the transport demand between the services associated with the
20 first and second placement variables;

21 placement constraints for the services which ensure that the services are
22 placed onto the nodes in accord with the placement indicators; and

23 an objective; and
24 employing a local search solution to solve the integer program which
25 determines the placement of the services onto the nodes.

1 18. (Original) The computer readable memory of claim 17 wherein a particular
2 placement indicator comprises an indication that a specific service is to be placed
3 onto a specific node.

1 19. (Original) The computer readable memory of claim 17 wherein a particular
2 placement indicator comprises an indication that a specific service is not to be placed
3 onto a specific node.

1 20. (Original) The computer readable memory of claim 17 wherein a particular
2 placement indicator comprises a neutral indication of whether a specific service is to
3 be placed onto a specific node.

1 21. (Original) The computer readable memory of claim 20 wherein a default for the
2 placement indicators comprises the neutral indication.

1 22. (Original) The computer readable memory of claim 20 wherein a matrix is
2 specified which expresses constraints or preferences for identifying a placement of
3 services onto nodes.

1 23. (Previously Presented) A computer readable memory comprising computer code
2 for directing a computer to make a determination of a placement of services of a
3 distributed application onto nodes of a distributed resource infrastructure, the
4 determination of the placement of the services onto the nodes comprising the steps of:
5 establishing an application model of the services that comprises processing
6 demands for the services, storage demands for the services, and transport
7 demands between the services;
8 establishing an infrastructure model of the nodes that comprises processing

9 capacities for the nodes, storage capacities for the nodes, and transport capacities
10 between the nodes;
11 establishing a placement model comprising placement indicators for the
12 services;
13 forming an integer program that comprises:
14 a set of placement variables for a combination of the services and the
15 nodes, each of the placement variables indicating whether a particular service
16 is located on a particular node;
17 processing constraints which ensure that a sum of the processing demands
18 for each of the nodes does not exceed the processing capacity for the node;
19 storage constraints which ensure that a sum of the storage demands for
20 each of the nodes does not exceed the storage capacity for the node;
21 first placement constraints which ensure that each of the services is placed
22 on one and only one node;
23 second placement constraints which ensure that the services are placed
24 onto the nodes in accord with the placement indicators;
25 communication constraints between node pairs which ensure that a sum of
26 the transport demands between a particular node pair does not exceed the
27 transport capacity between the particular node pair, each term of the sum
28 comprising a product of a first placement variable, a second placement
29 variable, and the transport demand between the services associated with the
30 first and second placement variables; and
31 an objective of minimizing communication traffic between the nodes and
32 balancing processing loads on the nodes; and
33 employing a local search solution to solve the integer program which
34 determines the placement of the services onto the nodes.